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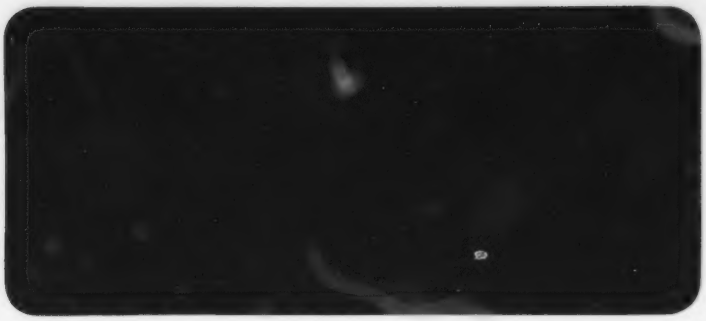

CANADA/NEW BRUNSWICK
CONSERVATION AND
ALTERNATIVE ENERGY AGREEMENT

L'ENTENTE CANADA/NOUVEAU-BRUNSWICK
SUR LES ÉCONOMIES D'ÉNERGIE
ET LES ÉNERGIES DE REMPLACEMENT

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Pro-Fisher Seminars

1988

Prepared and Delivered by

Maritime Marine Consultants Ltd.
Rothesay, N.B.

Prepared For

Dept. of Natural Resources & Energy
Minerals & Energy Division

D I S C L A I M E R

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Department of Natural Resources
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Executive Summary

The Seminars were intended to transfer information obtained in previous research studies to the fisherman to lower energy consumption in the fisheries transportation sector. Many of the attendees were very concerned with their present levels of fuel consumption and very interested in means of conserving energy.

A reoccuring problem that seemed to be common throughout the province that fishermen are not well enough informed to properly spec out their boats. From the data collected at the Seminars, it was obvious that by modifying various components of the vessel, energy consumption could be decreased. The attendees were very responsive to suggestions developed throughout the course of the program and returned to their communities with many ideas.

1.0 Introduction

There are over 3670 fishing vessels (35' to 65') in New Brunswick with fuel consumption of 15,000,000 gallons. Fuel bills constitute up to 60% of the operating costs of fishing vessels. As a result of some Nova Scotia and New Brunswick CREDA projects conducted between 1979-84 and Fisheries and Oceans Canada Research & Development Program on Fishing Vessel Economy, it is now possible to advise fishermen of fuel economy opportunities that they can implement at little or no cost. This Program has been carried out in Newfoundland and was found to be a very effective technology transfer medium. Last fall, the Gulf Region of Fisheries & Oceans Canada presented a three hour seminar/workshop to New Brunswick fishermen at four various locations. Fisheries & Oceans reported that the seminars were very valuable to fishermen and "participants recommended continuation and/or expansion of these workshops".

During the 1987-88 fishing off-season, the New Brunswick Department of Natural Resources & Energy along with Energy, Mines and Resources Canada conducted the Pro-Fisher Seminar Program directed towards the large inshore fleet less than 65' (20m).

The report that follows is the recommendations and results of the 1987 Pro-Fisher Seminar Program developed and presented by Maritime Marine Consultants.

2.0 REPORT ON PRO FISHER SEMINARS - 1988

2.1 Introduction

Section 2.0 reviews the Pro-Fisher Seminar program from commencement to completion. The reactions and suggestions are those of Maritime Marine Consultants Ltd. and do not reflect the reactions of the sponsoring Canadian Federal and Provincial Departments.

2.2 Venues

Seminars were presented in the following locations and the dates and numbers of those attending are as follows:

Location	Dates	Persons
Dipper Harbour	7/3/88	4
Campobello	9/3/88	6
Deer Island	11/3/88	4
Richibucto	14/3/88	16
Cap Pele	16/3/88	10
St. George	18/2/88	13
Caraquet	21/2/88	13
Shippegan	23/3/88	3
Lameque	24/3/88	1
Neguac	28/3/88	17
Baie Ste. Anne	30/3/88	5
Grand Manan	5/4/88	2
	Total	94

As can be seen from the table, attendance levels varied with respect to dates and location of presentations. Some contributing factors to this variance include:

a) The subject of energy conservation alone is not attractive enough a subject to draw the fishermen, especially as the cost of fuel oil was lower in 1987 than 1985.

b) The program was one (1) month too late in commencing as many fishermen were already involved in fishing or in final preparations for the season. Added to this was the early break up of the ice in the Bay of Chaleur.

c) There was conflict in time with marine courses re: examinations in navigation, fishing master and engineer's certification.

d) Publicity through the official medias such as newspapers, television and radio do not appear to be as effective as local advertising in stores, clubs and churches.

e) The poster itself, whilst technically informative did not stand out and so, from Richibucto on, colour was added. The matter of financial benefits of energy conservation would probably have been a more effective drawing card.

f) In general, fisherman organizations and Fisheries Departments did not spread the information, even though they were contacted and supplied with posters.

g) Cooperation from the fisherman organizations and both Fisheries Departments were less favorable than expected. All the necessary information was passed onto the officials, but the message did not seem to flow through to the fishermen.

It should be noted that the publicity effort was stepped up throughout the program and the monies spent in this area was a little over the budgeted figure, but timing was essential in obtaining attendance; it must not conflict with the normal fishing timetable. January or possibly mid summer would have been more suitable times to hold the seminars.

2.3 Seminar Content

As will be seen from the final seminar content, the emphasis and content were changed from the original program in the following areas:

a) An expanded introduction re: energy costs and future trends as applied to the fishing vessel.

b) Expanded information re: propeller/engine design.

c) Rule of thumb guidance re: propeller clearances, immersion, thrust estimation and cavitation re: tip speed and thrust loading.

d) Distinct split made and emphasis moved, depending on major type of local vessel, displacement or semi-planning hull forms.

e) Dept. of Fisheries and Oceans produced films more tightly intergrated into the seminar and generally used as introduction to sections of the seminar.

f) A general tidying up of the seminar to make it more practical and less theorectical in its approach.

2.4 Areas of Concern

During the course of delivering the seminars, common areas of concern were becoming more and more prevalent. Without a survey of the Northumberland Strait fleet in detail we would estimate that approximately 65% of that fleet is still engined with gasoline engines. There are several reasons for this:

i) Diesel engine suppliers are competing on the basis of first costs and recouping their monies with expensive service and maintenance. The number of engines offered are too many to have sufficient numbers of one type of engine to provide the adequate local support required in service and spares. With the very short fishing season, to miss a week's fishing is financial disaster for the boat owner. Rapid and efficient service is a prerequisite and locally supported. Manufacturers/suppliers should be made aware of the potential market, in the order of 300 engines required. With respect to those vessels, engines with a low weight/power ration would have a distinct advantage as, apart from the hull form, the optimum operating speed is closely connected with the hydrodynamic lift/boat weight ratio.

b) There is real need for a study of the Northumberland Strait vessels that would establish, for the boat builders, the speed/power/propeller design relationship for each builder's boat. To maintain the proprietary rights, this information would be given to each individual boat builder for his use only. There would appear to be only about six or seven builders supplying this market. To do this on an individual owner's demand would be a much more expensive approach.

c) Especially at the well attended seminars, a real need for technical advise was expressed, especially when buying a new vessel. It would seem that this support would be invaluable and could be available either with the inhouse potential of the New Brunswick Department of Fisheries or by other means. The Field Officers help as much as they can but are either involved with specific design or research problems or administration of loans and construction.

d) As can bee seen from the final lecture text, we found that, in order to get the conservation point across the participants wanted to discuss technical aspects of fishing boat design. There were also many enquiries as to whether any financial assistance would be available, for instance, in switching from gasoline to diesel engine propulsion.

2.5 Future

With a little more refining it is felt that the seminar content could be developed and used in courses such as provided by the Caraquet School of Fisheries. Prior to this, however, it would be advantageous if the texts of the different seminars given in the Atlantic Region be compared and a set of seminar notes be developed from all lectures.

Fishermens' Associations and groups should be encouraged to request the lecture on a one visit basis with the onus on the fishermen to attend. This could be encouraged by circulation of the final overall text and data to the Associations.

Without trying to develop work for the marine engineer or naval architect, whoever gives the seminars must be sufficiently qualified to answer most technical questions off the cuff. Much of the final seminar content was developed by that means.

Both levels of Government should consider some realistic economic incentive to encourage the Northumberland Strait fishery to adopt the diesel engine and to this end a seminar text to the engine suppliers would not go amiss.

Finally, for the smaller shipbuilders, some program should be developed to aid them in selection of propeller and hull performance.

APPENDIX

APPENDIX I

PRO FISHER SEMINARS 1988 TEXT

PRO FISHER SEMINARS 1988

NEW BRUNSWICK

FINAL REVISED TEXT

1. Introduction:

We are pleased to welcome you to this seminar on energy use and conservation for smaller fishing vessels less than twenty (20) metres in length overall. The workshops are presented under the auspices of Energy, Mines and Resources Canada, and the New Brunswick Department of Resources and Energy with valued advice and support from both Fisheries and Oceans Canada and the New Brunswick Department of Fisheries and Agriculture and are funded under the Canada/New Brunswick Conservation and Alternative Energy Agreement.

We hope that you will actively participate in two way discussions as feed back from the fishermen is greatly appreciated and will help in development of future seminars.

2. Historical Background:

The fuel oil energy crisis of the late 1970's and early 1980's brought to light two significant factors:-

a) That natural crude oil is not a renewable and inexhaustible resource, and

b) that the price of oil will, over the long term, continue to rise at an ever increasing rate as its supply dwindles and that the recent fall in prices is only a temporary reprieve due in a large part to conservation measures taken by the developed, industrial nations.

It is estimated that these nations reduced their consumption by some 40% whilst previously consuming

NEW BRUNSWICK FLEET VESSELS OVER 15 G.R.T.1986 FIG 1

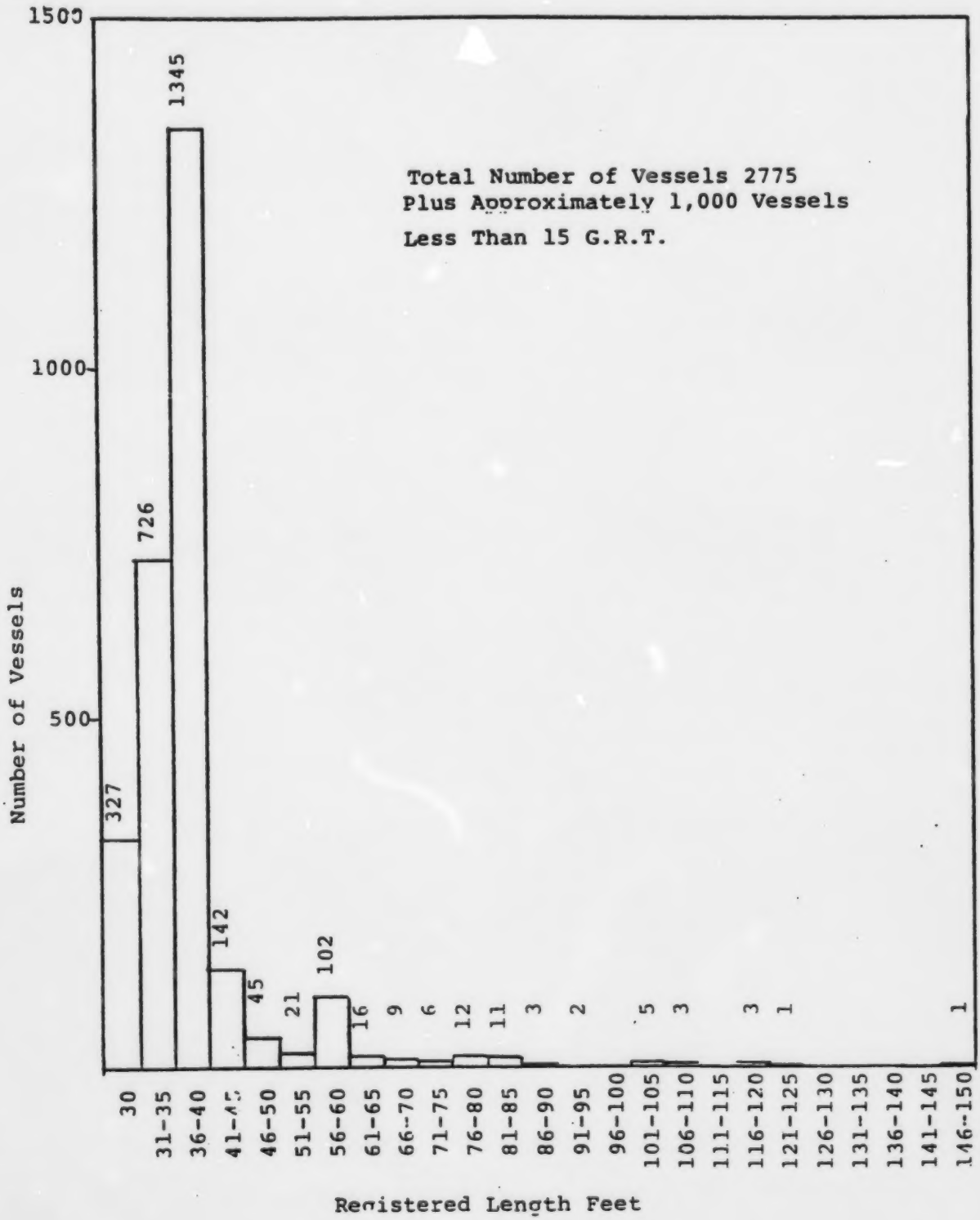
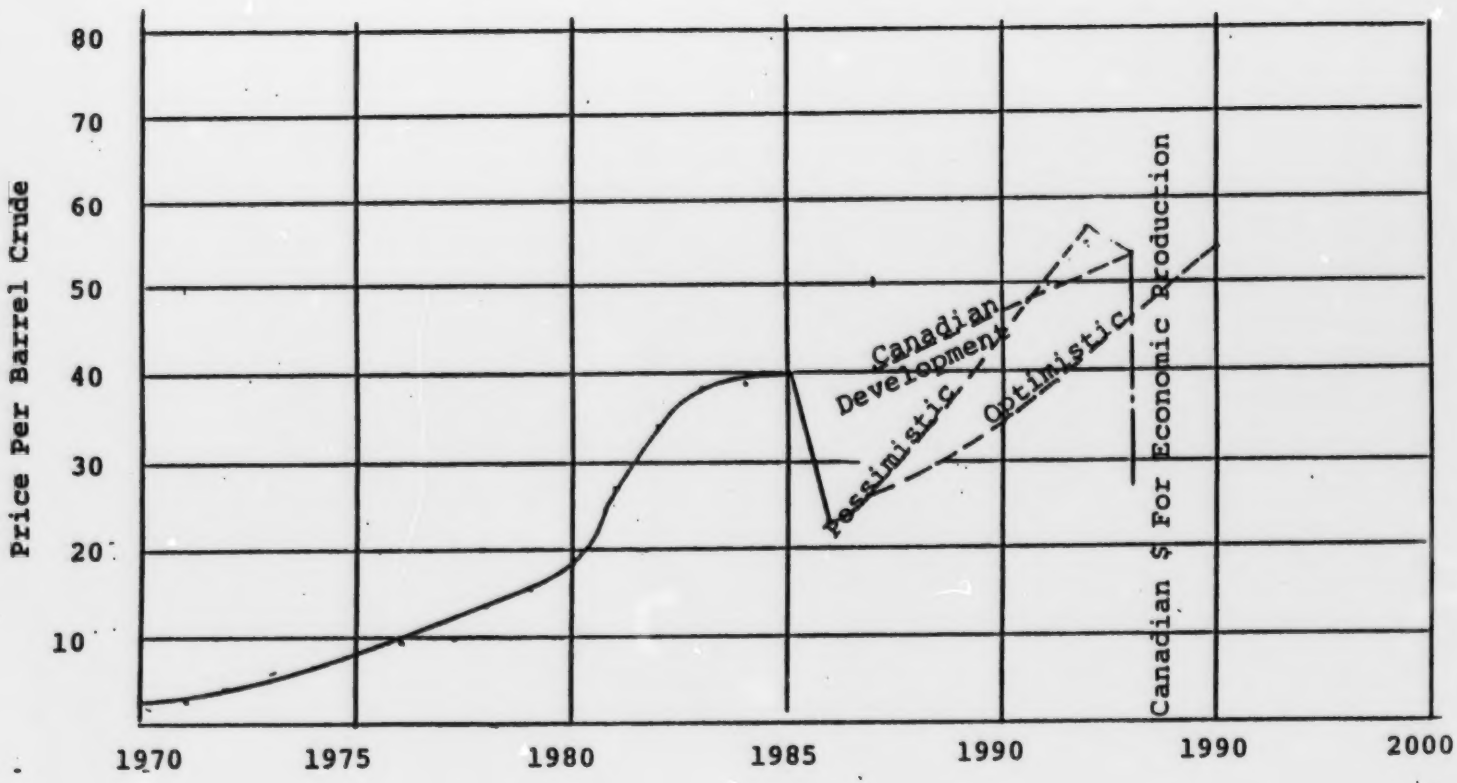


FIG 1B

ESTIMATED COST OF CRUDE OIL



2. Historical Background: (cont'd)

something like 90% of the oil produced. Simultaneously oil producing countries have continued to virtually export the same amount of oil to finance their own development and internecine wars.

FIG 1 If we review the crude oil costs since 1970 it is clear that the increase in price has been dramatic and erratic. The price of crude in 1970 was $2.51/barrel and rose to a high of $38.01/barrel in 1985. The average increase over the past seventeen years has been 17%/annum whilst averages over five year periods since 1970 have been 27, 18 and 17 from 1970 - 85. The effects of conservation can be clearly seen since 1983, however, the increase of 20% in 1987 could be an indicator that the market has adjusted between supply and demand and the cost will rise steadily again.

FIG 1B If we attempt to do a little crystal ball estimating and assume that the increase of 1987 will continue to rise at 20%/annum and that the average inflation will be 5% some interesting predictions can be made. In 1987 the magic figure of $40/barrel was considered as being a viable figure for Canadian development of oil production. If we assume that these costs continue to rise at 5% we find that by 1991 the world price and production price balance at $48/barrel. Assuming that Canadian production takes two years to become effective we have a maximum of $57/barrel in 1993 and a fall to $53/barrel once Canadian production takes over. If we then go up the 5% line by the year 2000 crude oil will cost some $74.50/barrel. In 13 years the cost of fuel could triple. Fish on the other hand will probably follow the 5% inflation and only increase by about 90%.

2. Historical Background: (cont'd)

One of the main factors that can influence these curves is conservation. Even if only half the savings could be made in the 1980's as were made in the 1970's and the increase in price kept to 10%/annum we would have the "optimistic" curve. There would be about a three year delay in the system but by 2000 we will be stuck with the same cost of $74.50/barrel. Therefore, we are faced with no alternative but to use less fuel to catch the same amount of fish, while we give ourselves as much time as possible to generate alternative mobile energy.

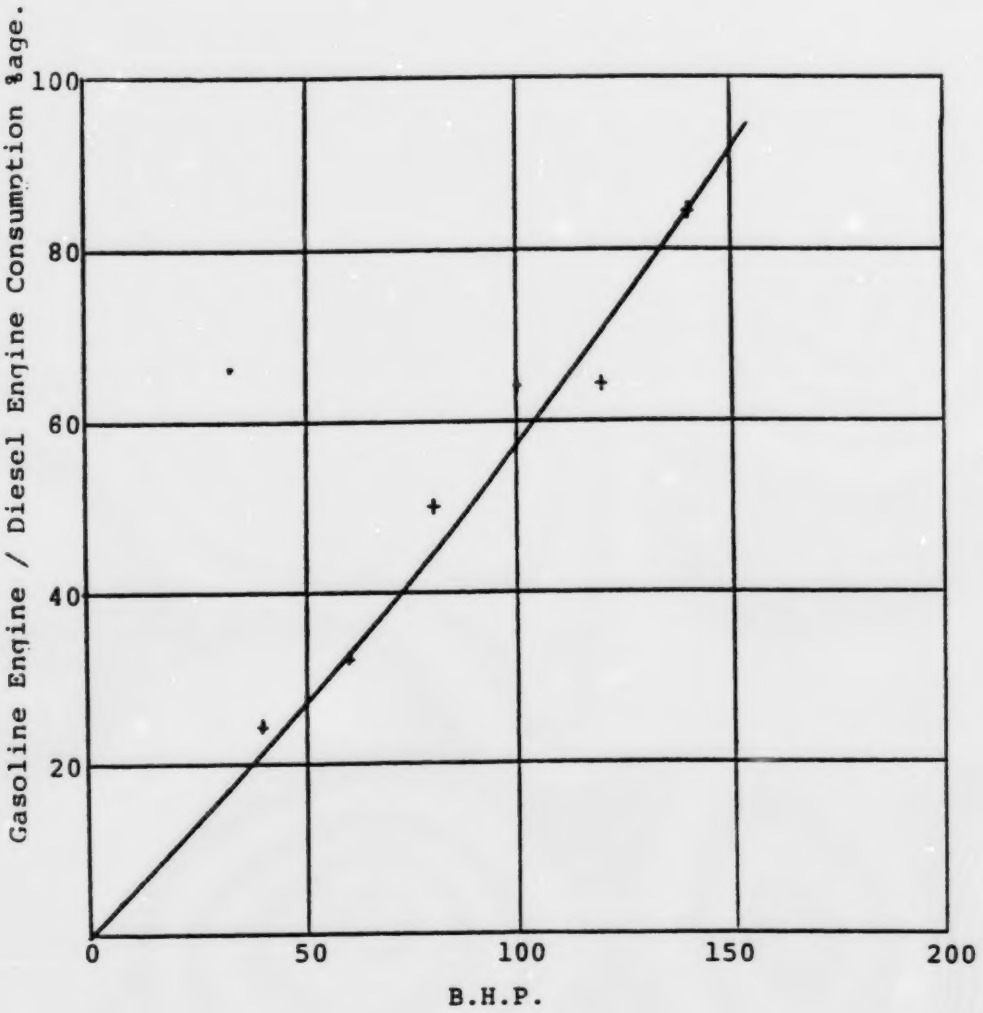
This is not going to be easy to achieve, especially when the present conservation has been the result of better use of private and public transportation and the use of alternative fuels such as wood, coal, atomic or hydro-electric power for stationary power services.

With respect to the area of the fishing fleet we are considering, various Federal and Provincial Departments concerned have undertaken work in the conservation area and much of the information given here is amplification or variations of that work.

The most notable of these programmes is the ENERSEA program undertaken in Newfoundland by Fisheries and Oceans, Industrial Development Branch together with the Newfoundland Provincial Department of Fisheries. This programme is mainly directed toward achieving good design compatibility between vessel speed, main engine power and propeller design for the "long liner" displacement hulled vessels. Onboard measurements were made of vessel speed and fuel consumption before and after suggested modifications were made to the vessels. Estimates were made using a computer system housed in a van visiting the fishing communities that would handle changes in the propulsion system,

COMPARISON OF GASOLINE VERSUS DIESEL ENGINE FUEL CONSUMPTION

FIG 2



2. Historical Background: (cont'd)

fairing of the skeg area, cleaning and repainting of the hull and the introduction of a propeller nozzle on dragging vessels. The fuel oil consumption and speed measurements were used in obtaining some correlation between the computer estimates and the vessel results. The computer software, however, is closely suited to the Newfoundland fleet.

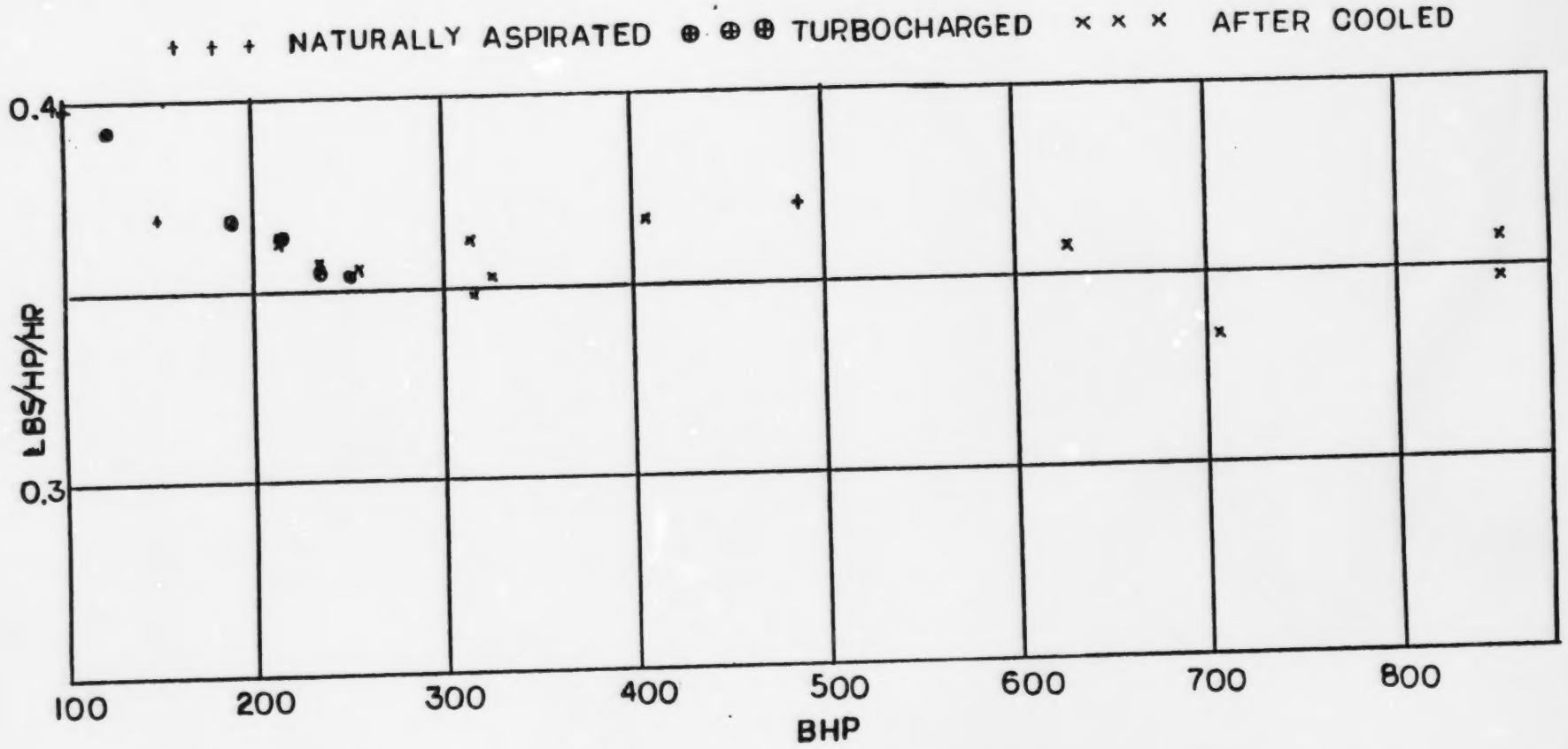
3. The New Brunswick Situation:

The single most important factor that was closely illustrated was that speed costs money, especially for the displacement type vessel. We will be drawing on the ENERSEA results together with the videos produced by the same group but we will take a much broader sweep of the fishing vessel energy consumption situation.

FIG 2 The first factor is that 98% of the New Brunswick fleet in terms of number of vessels lie within the length range of less than 20 m (65 ft.) whilst 94% are less than 50 ft. in length and are semi-planing vessels, with power characteristics vastly different to the Newfoundland displacement vessels.

The total New Brunswick fishing fleet consists of some 3700 or so vessels with 2775 over 15 gross registered tons. The estimated total replacement (1988 dollar values) would be in the order of $450,000,000. To give some indication of the fuel consumption we would estimate that if the entire fleet were to operate at an average of half full power the consumption would be about $20,000. per hour. To put it another way, based on the subsidy paid out on fuel in 19 the average consumption was some gallons.

FIG 3 VARIATION IN DIESEL ENGINE FUEL CONSUMPTION



4. Main Engine:

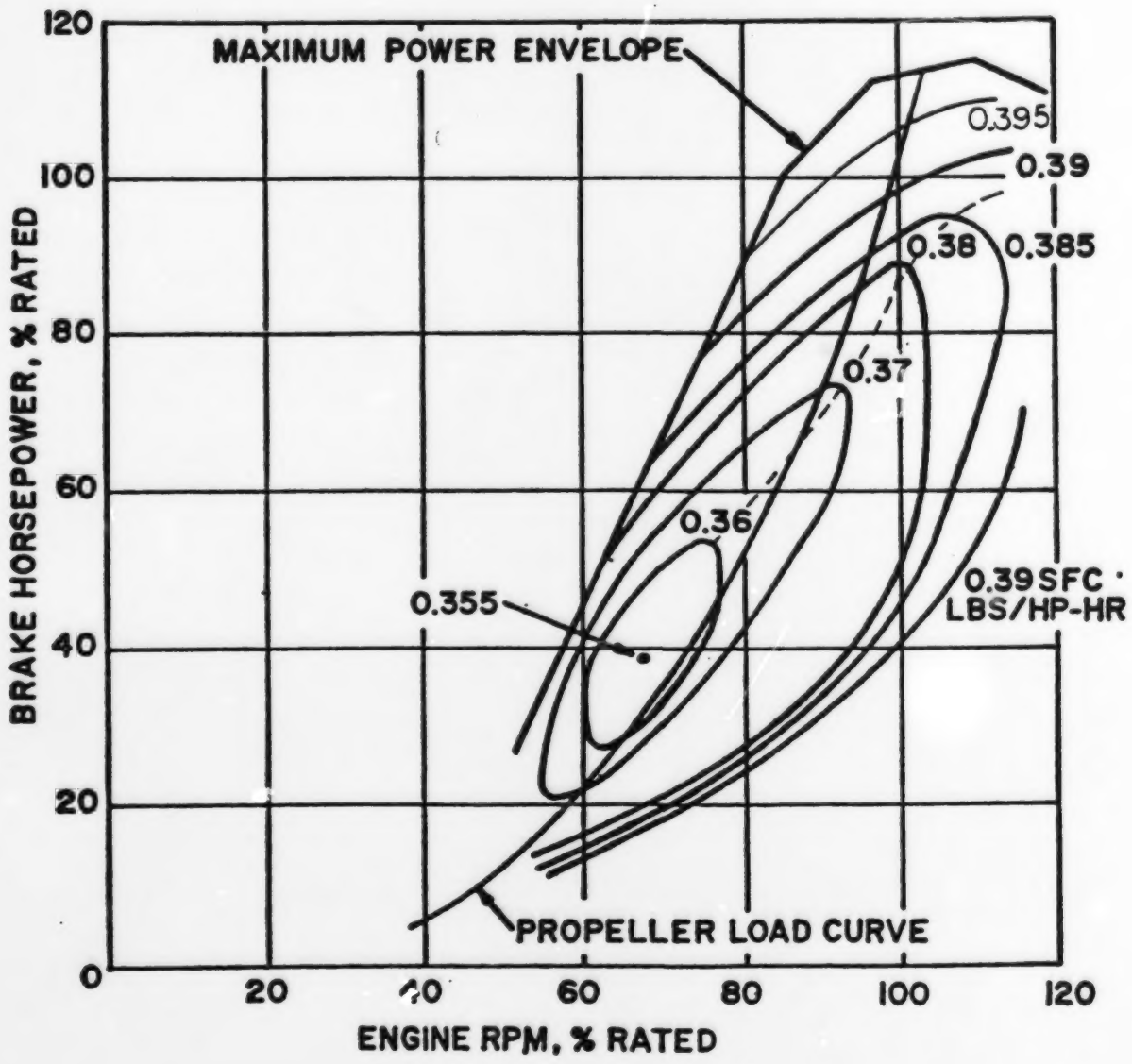
FIG 3. The major fuel consumer is the main engine and the initial decision to be made when renewing the vessel on the main engine is whether to fit a diesel or gasoline engine. Purely from the fuel consumption aspect there is no choice but diesel. Fig 3 indicates the increase in percent of the gasoline engine consumption as compared with that of the diesel engine and is based on the consumption of diesel or gasoline driven generators supplied by the same manufacturers. Similar figures were obtained from other suppliers data. At 50 bhp + 27%,at 100 bhp + 58%,and at 150 bhp 92%. A further 10 - 15% should be added to the differences to allow for the larger amount of crude required to refine a unit volume of gasoline as compared with diesel.

We would estimate that approximately 2,200 vessels (65%) of the fleet less than 45 ft. in length are still powered with diesel engines. Operating at half power the savings between diesel and gasoline would be 3800 gallons/hour or 30% of the total fleet fuel bill.

The factors holding back the complete introduction of the diesel engine, apart from those using outboards would appear to be as follows:-

a) The familiarity of the fishermen with the gasoline engine.
b) Readily accessible service and spare parts for the gas engine results in very little lost fishing time.
c) The high initial cost of the diesel engine installation between 2 to 3 times that of a gasoline engine.
d) The high cost of diesel service and spare parts and for some spare parts, long delays in obtaining parts with the vessel unable to fish.

SPECIFIC FUEL CONSUMPTION FIG 4



4. Main Engine: (cont'd)

e) The higher weight/power ratio of the diesel engine.

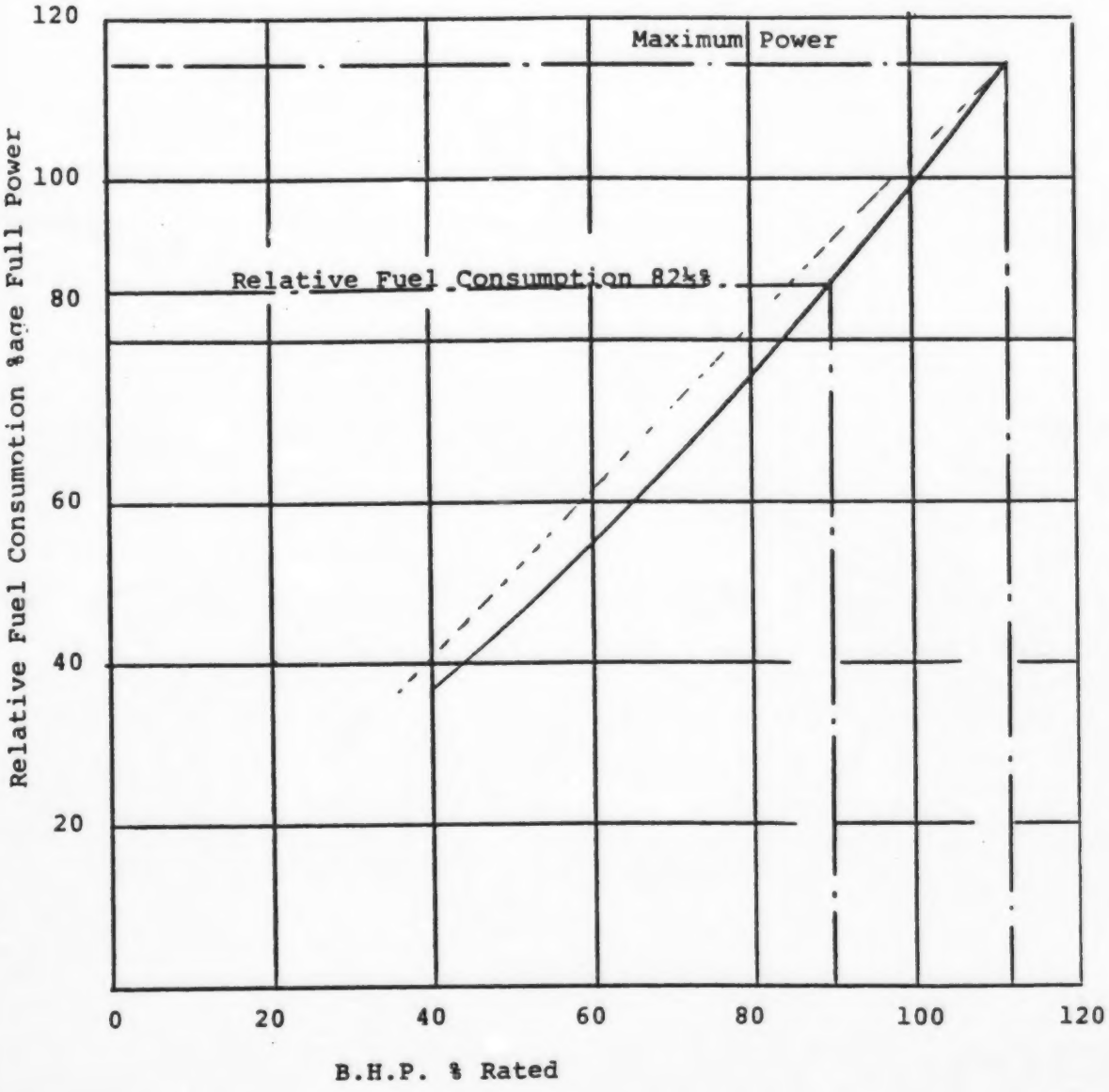
f) No present existing government monetary incentive either as a grant/subsidy to switch to diesel or a tax or significant cost differential in the cost of fuel.

FIG 4 Let us take a closer look at the diesel engine and variation in consumption with power and variations of engines, i.e. naturally aspirated, turbo-charged or turbo charged and after cooled. The graph is based on a North American manufactured, four (4) stroke diesel engine and are test bed results. This means that the engine is tested in ideal controlled conditions in the plant. The unit of comparison is normally the weight of fuel used per horsepower hour, specific fuel consumption.
As can be seen the consumption in lbs/hp/hour varies between 0.39 - 0.33 lbs/hp/hour (0.040-0.047 gallons/hp /hr). From an operating aspect the consumption figure used is 0.50 lbs/hp/hr (0.060 gallons/bhp/hour) for the North American engine. A well maintained European type design would have a consumption in the order of 10% better than the North American motarized industrial engine but, remember first costs and availability of spare parts from local dealers.

It would appear that only a determined public relations and sales effort on the part of suppliers, as fuel cost becomes higher, will change the attitude in favour of the diesel engine. With a larger number of engines installed both service and spare parts supply should improve.

g) Some recent applications of diesel engine installations have been poorly engineered. It has to be the right sized engine in the right application and well installed to work sensibly.

RELATIVE FUEL CONSUMPTION AT PROPELLER DEMAND LINE FIG 5



4. Main Engine: (cont'd)

Referring back to the graph, apart from the results at horsepowers below 150 the mean consumption can be taken to be about 0.36 lbs/bhp/hour (0.043 gallons/bhp/hr) for all the engines reviewed. The effect of turbo-charging or after cooling is to increase the power using the same engine block with little increase in the purchase price and the specific fuel consumption.

There are other ways of increasing engine power from the same block, by increasing the operating revolutions, by injecting more fuel, by super charging or by increasing the cylinder's pressure, etc. It should be remembered that we do not get something for nothing and any method of increasing the power of the same basic engine reduces the engine life and increases the maintenance costs.

The naturally aspirated engine will require replacement or a major rebuilding after about 12 years of operation turbo charged about 10 years and a little less for the after cooled engine. So the decision is pay now or later. More power basically means more engine wear.

FIG 5 We now come to the single diagram that will put the relationships between engine rpm, horsepower, propeller demand and fuel consumption on one sheet of paper and it is not as complicated as it might at first appear to be.

The "Maximum Power Envelope" gives the maximum power that the engine can generate at any revolutions on the manufacturer's test equipment. Reading from the curves we have at 60% rpm: 45% power, at 80% rpm 88% power, at 100% rpm 112% power and at 110% rpm 110% power.

The "Propeller Load Curve" gives relationship between rpm and power demand by the propeller, at 60% rpm 20% power, 80% rpm 51% power, 100% rpm 100% power (propeller design point) and at 103% rpm 112% power. The left hand boundary of the power envelope is effectively the propeller demand line and the maximum power will not

4. Main Engine: (cont'd)

be achieved. The propeller demands and the engine provides only that requirement.

The contours on the diagram are lines of constant specific fuel consumption and may be compared to the contours of constant depth shown on nautical charts. It should be noted that the specific fuel consumption increases at both the lower and higher revolutions with a minimum in the 70 - 75% rpm range. These rpm's will give the best power value for your fuel dollar. This leads to the concept of buying an engine with more available power than required and operates at reduced revolutions. However, the oversized engine should not be run at full rpm. in normal operation, only in an emergency situation. More power, as will be seen later, often means using little increase in speed or pull.

The ideal curve for the propeller demand would be if it could lie along the dotted line shown in the diagram, the line of maximum power for minimum fuel consumption. Once the propeller is designed it will only lie along one unique curve.

So much for theory. In practice, as will be seen from the film that follows, the propeller performance will drop dramatically if the propeller is overloaded and cavitation occurs. We do not design for the full 100% power because as the hull fouls up and becomes damaged, the propeller deteriorates and the engine efficiency drops with age. If the propeller were to demand the 100% power the engine would be permanently overloaded when providing it. There is an allowance made for this of 10% in power, which means the propeller is designed to absorb 90% of of full power with respect to diameter, pitch and revolutions. However, to avoid cavitation, should the additional available power be required in an emergency the blade area is sufficient

to avoid cavitation in the overload condition.

It is most important when buying an engine to establish with the supplier the true 100% r.p.m. and power figures. This point is known as the "Maximum Continuous Rating"(M.R.C.) of the engine and 90% of this figure is used in the propeller design. Do not be mislead by other ratings, "Pleasure","Intermittent" or "Standby", these are not the correct ratings. It should be remembered that the operation of a diesel engine at sea is not the same as running at constant speed in a land based plant. Considerable changes of loading constantly occur, both due to operations and in a seaway.

PICKING A PROP.

5. The Propeller

The video was an excellent introduction to propellers and we will now try to give some general guidance.

a) Hull/Propeller Clearances

Location	Clearance %age Diameter
Top of propeller	8-10%
Bottom of propeller	2-3%
Forward of propeller	25-30%
Between propeller and rudder	10-12%
Propeller immersion below waterline	100% displacement hul
	80% Northumberland Strait
Rake of shaft maximum	1 in 12

If these minimum clearances are not used the propeller will be very inefficient due to operating in the turbulence generated by the adjacent hull or by cavitation built up on the propeller tip every time it passes the hull.

5. The Propeller Cont'd.

A propeller is an impeller that works best in a smooth streamflow at constant velocity. Too small a clearance at the top of the propeller can also lead to vibration.

The second cause of vibration can be the frequency of the blades passing the hull being close to the natural frequency of the hull or components of the hull. The simplest way to remove this problem is to change the number of blades and thus the blade tip frequency.

b) Cavitation

Cavitation is generated by two(2) main causes, either excessive propeller blade thrust loading or too high a tip speed. Small amounts, up to 5% of blade back cavitation is acceptable and will cause no significant blade surface damage or loss in efficiency The following is a "ball park" guidance:
The blade thrust loading should be less than 10 lbs./ins^2.
The approximate thrust for a free running propeller well designed is about 15 lbs./bhp. Therefore the blade area required for a free running propeller would be 1.5 bhp. in square inches. For an open towing propeller this would increase to 2.5 bhp. and for a propeller in a nozzle about 3.0 bhp.

For the propellers that we are considering the maximum optimum diameter cannot be fitted because of the small aperture available.

5. The Propeller Cont'd.

The first requirement when designing a propeller is to consider the vessel's operation and speeds. If you are far from the grounds and do not drag then the propeller should be designed for the free running speed. If you mainly drag and are reasonably close to the grounds then the propeller should be designed for the dragging speed. If you do a bit of dragging and other fishery a compromise speed should be selected. The effect is as follows:

Vessel speed	Propeller Efficiency
Free running	High free running/poor towing
Dragging	Poor free running/high towing
Compromise	Some loss both free running and towing.

The type of hull also effects the propeller design and is reflected in adjustments made to the speed of inflow into the propeller and an adjustment to the theoretical thrust. The vessel drags with it some water when underway and,therefore in general, the water speed behind the vessel is reduced when compared with the vessel's speed. This water speed into the propeller is known as the wake speed. The thrust calculated from the propeller charts,is for a propeller working in an open stream of water behind the vessel, this water speed is neither smooth nor evenly distributed over the propeller blades. This reduction in thrust is normally known as the thrust deduction. Typical values for types of hull are given below, however, variations in the hull shape and speed can vary these values to a degree:

5. The Propeller Cont'd.

Hull Type	Wake Coefficient	Thrust Deduction
Full displacement	0.80 - 8.85	0.85 - 0.90
Semi-planing	0.90 - 0.95	-.95 - 1.00

Example Full Displacement Vessel 10 knots.

Chart thrust 15,000 lbs.

Wake speed 0.80 x 10 = 8 knots

Thrust 0.90 x 15,000 = 13,500 lbs.

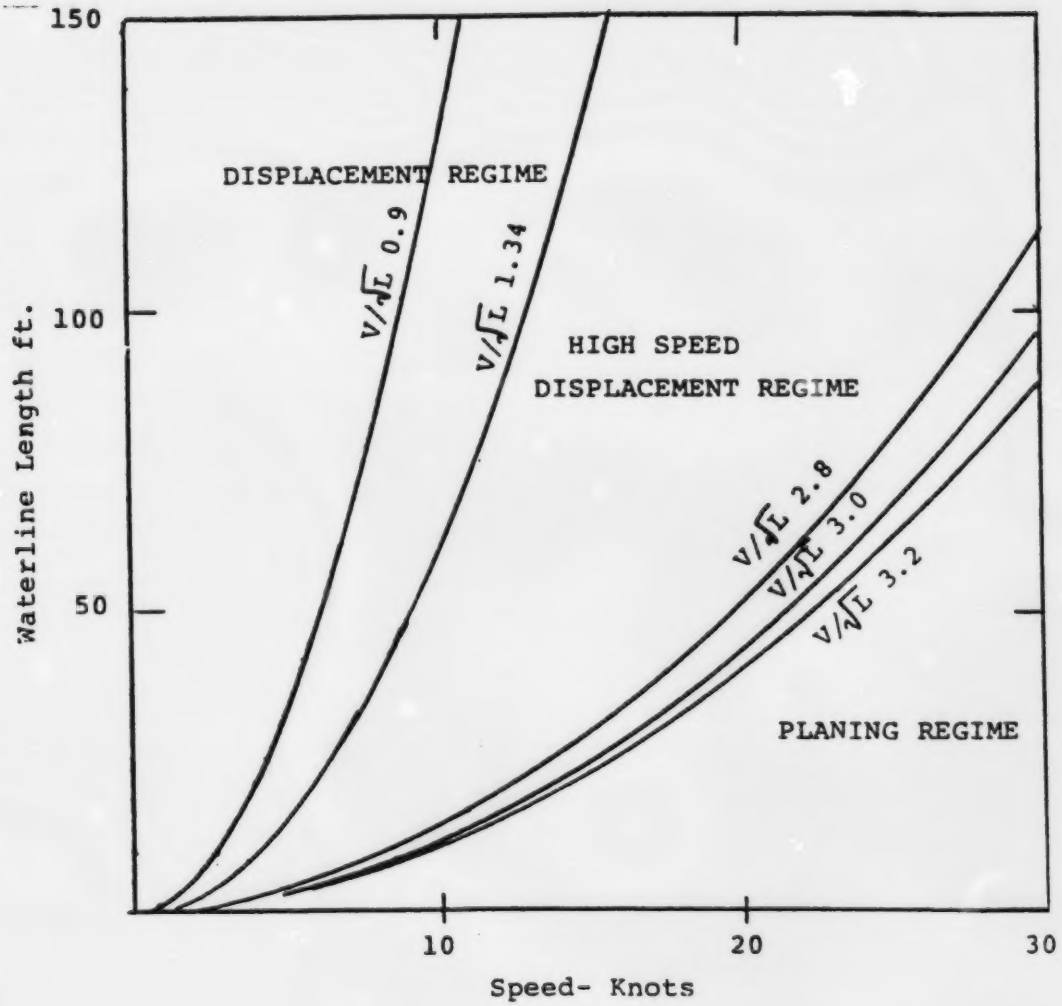
A word of warning with respect to the fitting of steering nozzle on fishing vessels; poor steering characteristics can result, especially when manouvering astern. This situation is improved if the nozzle is fitted with an independent rudder.

Controllable pitch or two pitch propellers have been installed in vessels having two distinct modes of operation, such as the trawler and the crab vessel. Apart from the initial cost apsect, in the order of $50,000 for a 65' vessel, increase cost over a fixed pitched propeller, problems have occurred in maintaining the seals on the oil filled stern tube, especially when operating in sandy areas or shallow water.

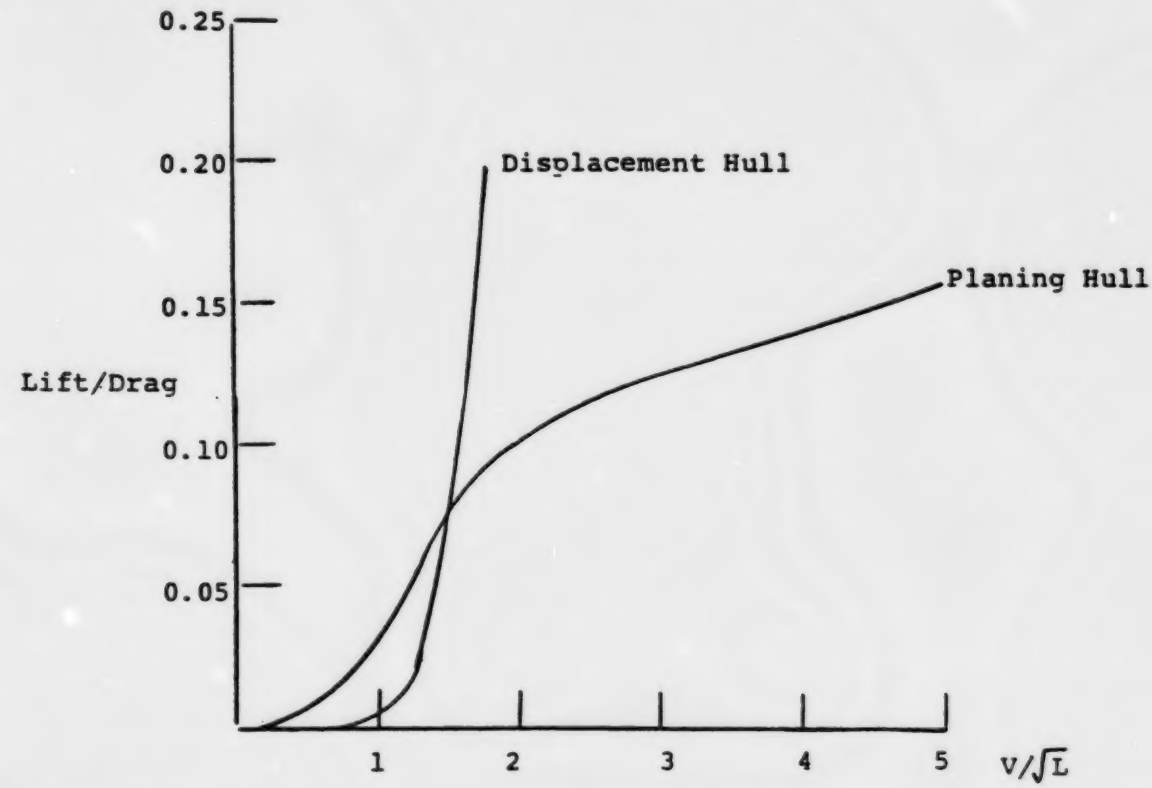
A final remark on the propeller design concerns the allowance made for the deterioration of the propeller, hull and engine with time. If the propeller were designed to absorb 100% of the power, as the propeller and engine efficiency falls and the hull drag increases, the demand on the engine increases and, with time, the engine would be operating constantly overloaded. To allow for this situation the propeller is designed to absorb 90% of the engine power but to avoid cavitation and lack of response in emergency the blade area is sufficient to absorb full engine power.

SPEED REGIMES

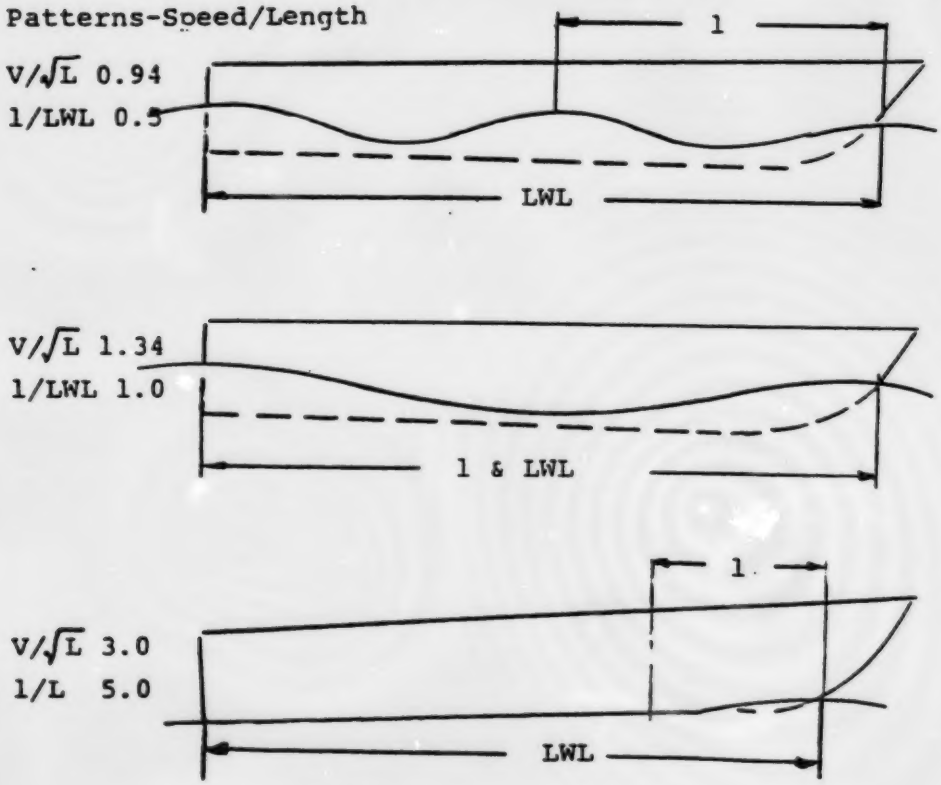
FIG 6



TYPICAL DRAG/LIFT RATIO VERSUS SPEED/LENGTH RATIO FIG 7



Wave Patterns-Speed/Length



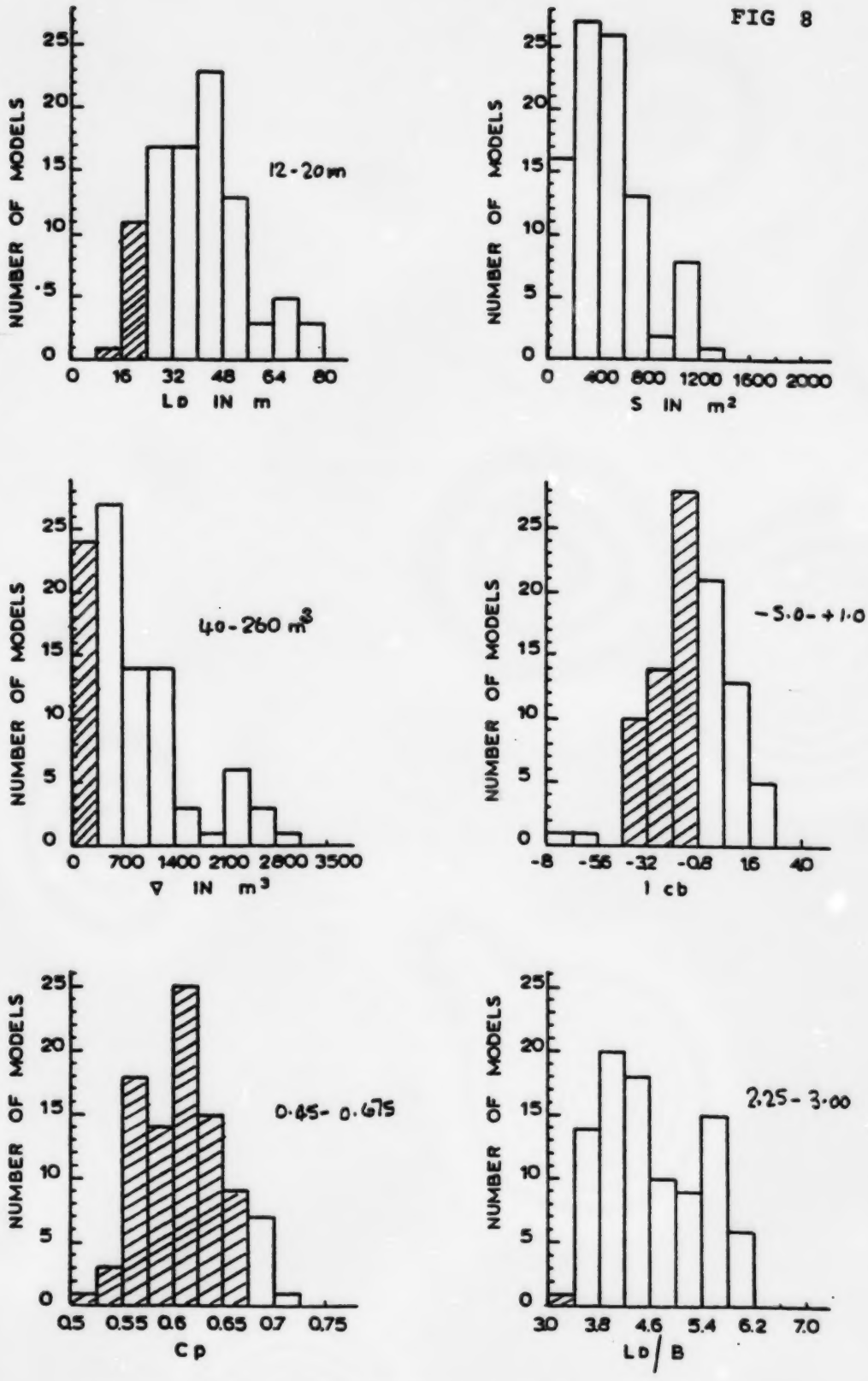
6. Hull/Propeller Interaction

The ENERSEA programme has been very successful for the Newfoundland "Long liner" fleet and the coefficients contained in it are fixed values for that fleet. It is therefore not applicable when determining the propeller requirements for the mixed designs of the New Brunswick fleet. To this end the programme could be modified to reflect a larger range of operation and design. These coefficients should reflect at least whether the vessel is a displacement, semi-displacement or planing vessel.

FIG 6 This figure illustrates the essential differences and types of curves to be anticipated in fishing vessels. Hulls fall into two main groups of displacement and planing type hulls and unfortunately much of the New Brunswick fleet operate in the "no-mans land" between.

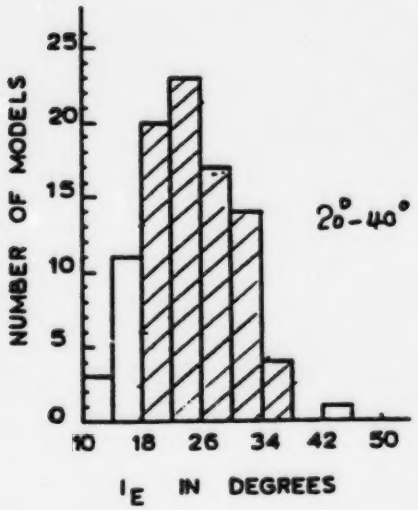
FIG 7 The displacement type hull is as implied, a hull form for carrying cargo, and as such pushes its way through the water and therefore creates surface waves. If the drag/speed curves are reviewed at lower speeds the wavemaking is not significant and the drag is mainly caused by the frictional drag of the water passing over the hull. At higher speeds the wavemaking resistance increases dramatically. At about a speed/length ratio of 1.34 the wave speed and the ship speed are the same and therefore the wave resistance increases with little or no increase in speed. This is the upper limit of the displacement type hull and the vessel is too heavy to get sufficient lift to rise out of its own waves.

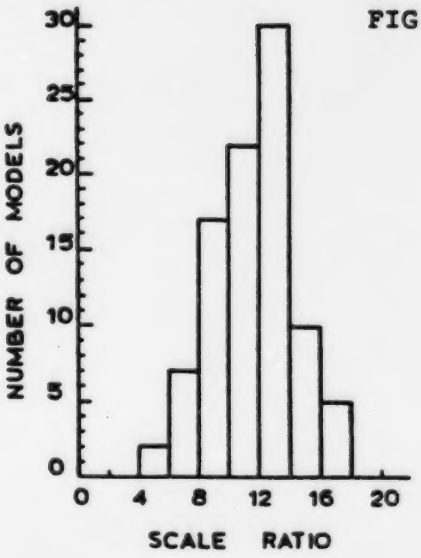
FIG 8

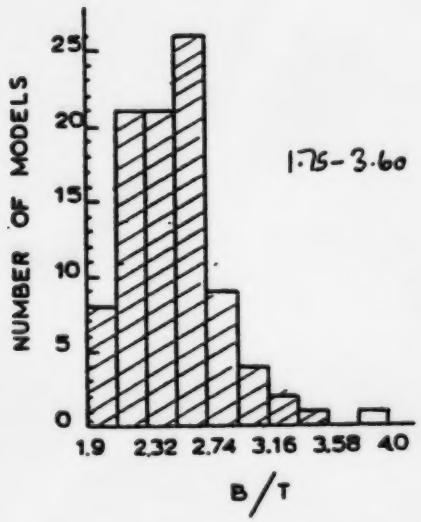


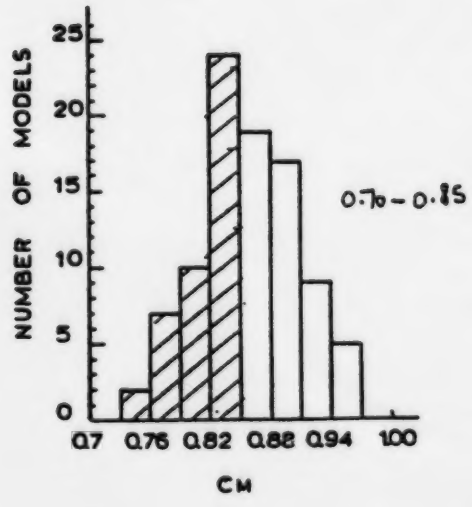
DATA COVERAGE USING S.N.M.B. PUBLICATION 391

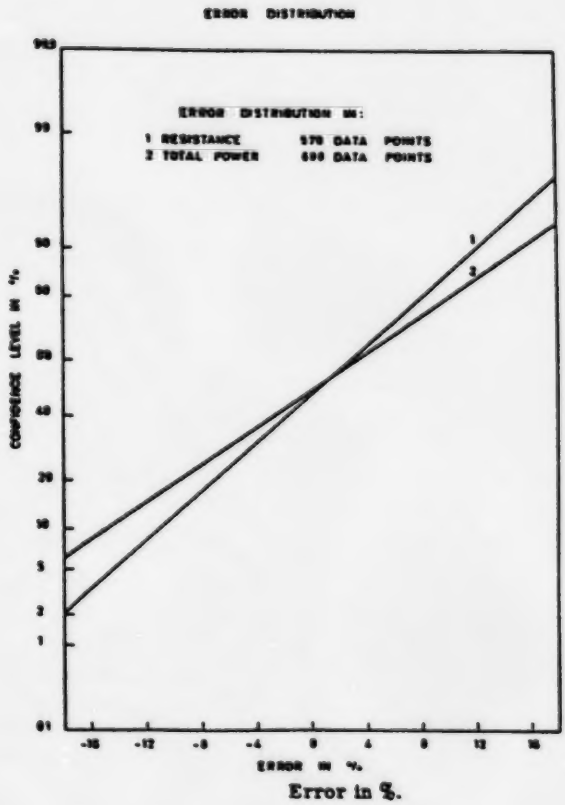
FIG 9





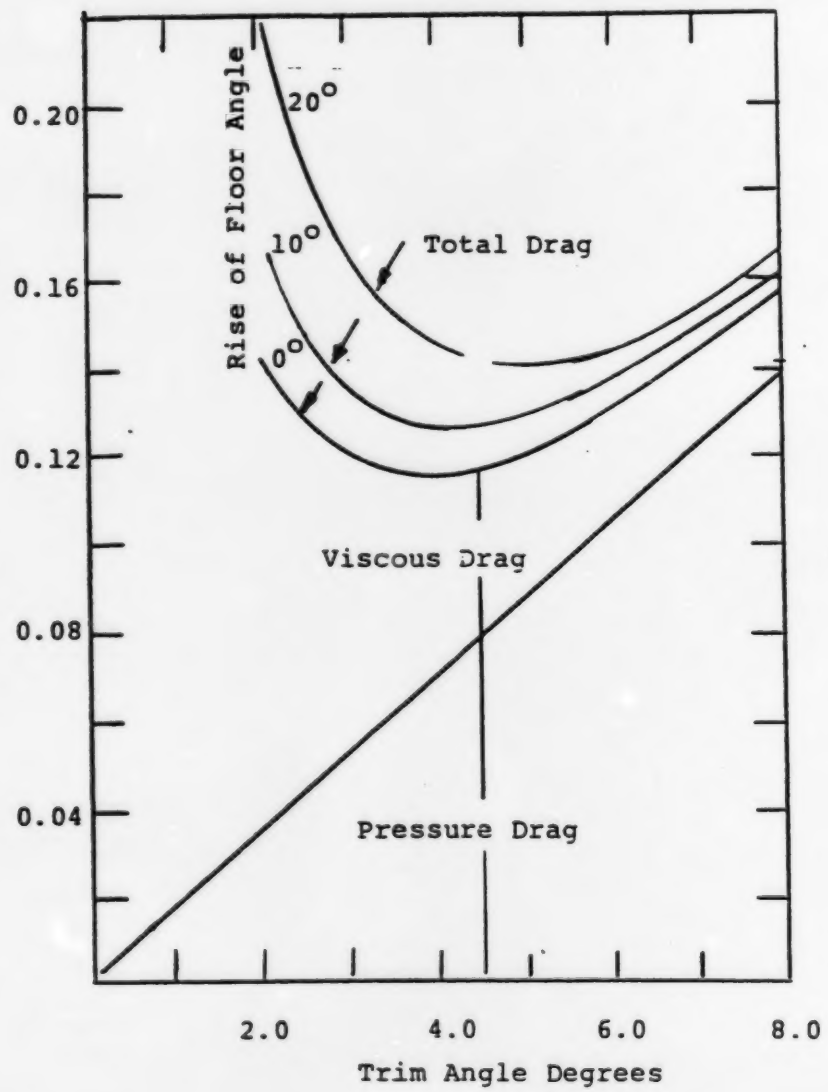






DATA COVERAGE USING S.N.M.B. PUBLICATION 391

VARIATION OF LIFT DRAG/RATIO FOR PLANING VESSELS FIG 10



6. Hull/Propeller Interaction Cont'd.

The planing type hull on the other hand, has low displacement and a flat lifting surface underneath. Thus by the 1.34 barrier, sufficient lift has been generated by the flat hull sections to raise the vessel out of the waves. Full planing occurs at speed/length ratios in excess of 2.3 with the vessel skimming on the surface with only frictional drag.

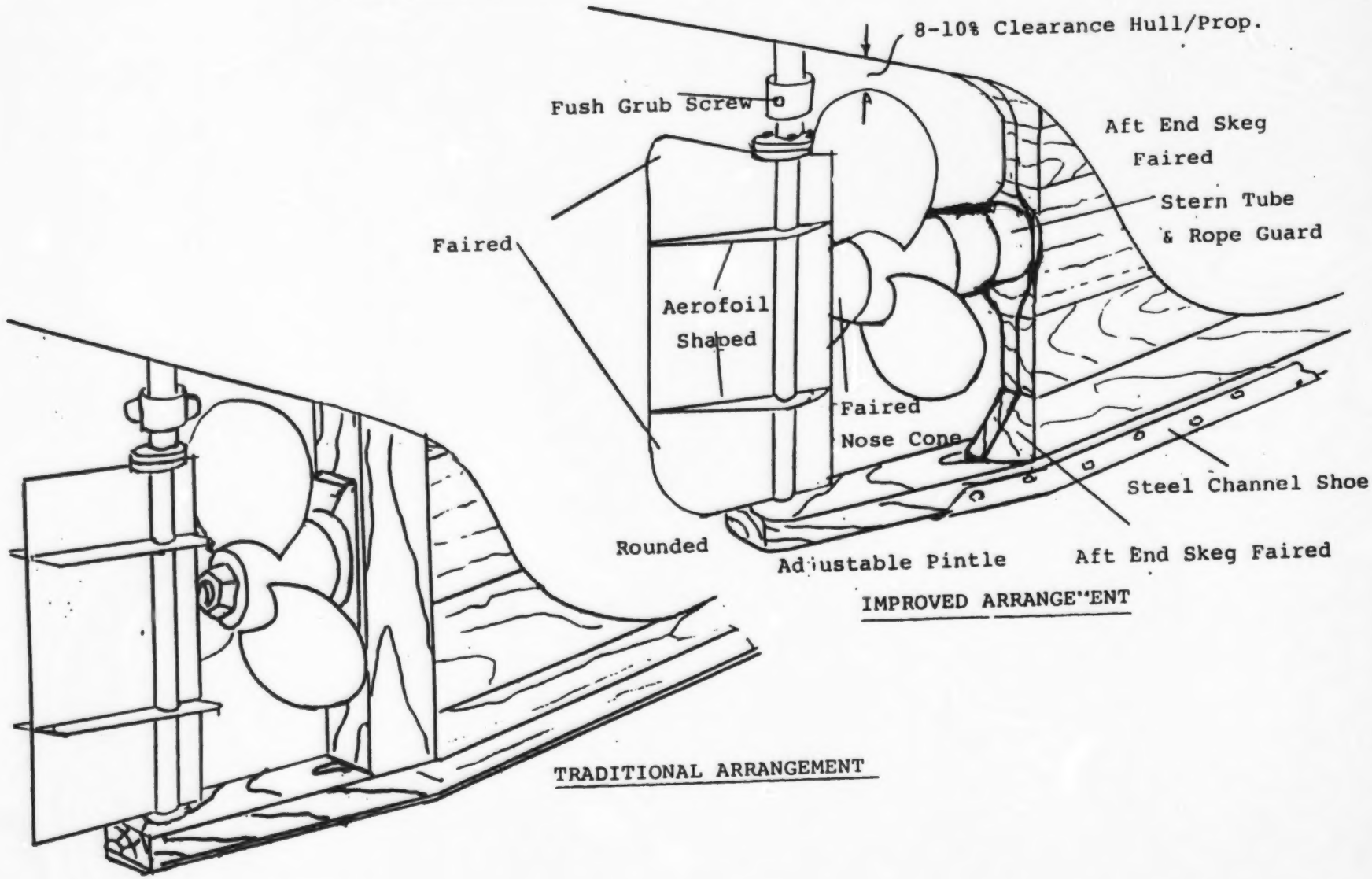
The two types of hulls are dramatically illustrated when the planing vessel carries herring, it becomes a displacement type vessel and loses as much as ten knots in speed.

FIG 10 Much of the woes of the lack of speed of the planing vessel has been blamed on the propeller but we would like to illustrate by the diagram, minimum total drag occurs at trim angles between three and five degrees, depending on the transverse slope of the sections. Below 3^{o} and above 5^{o} there is a dramatic increase in drag. The vessel either ploughs into or tries to climb its own bow wave. Therefore small changes in trim can bring dramatic changes in speed.

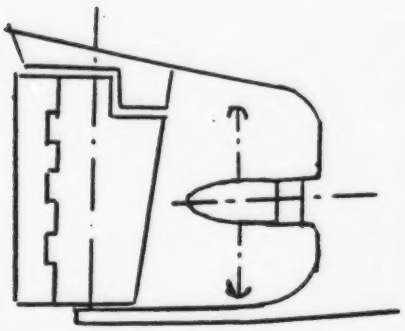
FIGS 8 & 9 These two graphs illustrate the range and quantity of data from ship/model tests available in the most used data for small vessels from the S.N.M.3 Mutenwerf publication. It is not important exactly what coefficients mean but they are coefficients that describe the hull form. What is significant, when one reviews the shaded areas that define the data applicable to small fishing vessels, is that there is a significant lack of data at the low LD/B, length of waterline/beam for values of less than 3.0. Most modern designs because of the increase in length and

FIG 11

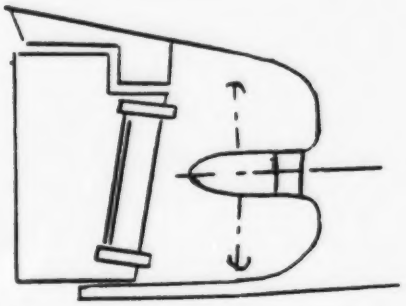
STERN ARRANGEMENTS



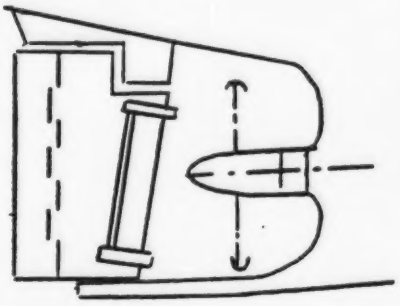
RECENT RUDDER INTRODUCTIONS FIG 12



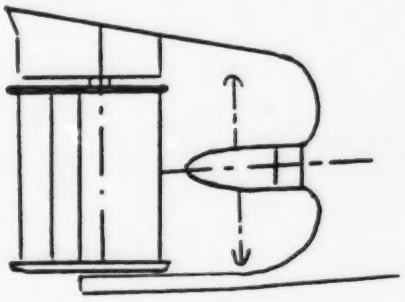
Improved Flap (Becker)



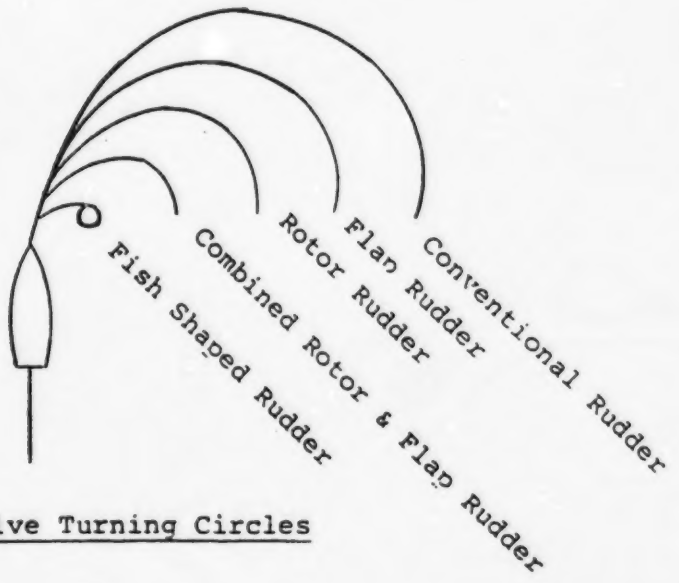
Rotor Cylinder Rudder



Combined Rotor and Flap



Fish Shaped Section (Schilling)



Relative Turning Circles

6. Hull/Propeller Interaction Cont'd.

the ceiling of 65 ft. length for inshore vessels, have values much less than 3.0. This means if the powering method is used we are working outside the data and assuming the relationships continue to hold true outside the range of the data. There is a very real need, if the present length restrictions are not relaxed, to carry out model or full scale trials to obtain data that can be added to the data bank and analysed.

There is a further problem with respect to precise prediction of hull performance in that many modern steel and aluminum vessels are chined and the effect on resistance of these chines is not known.

7. Appendage Design

FIG 11 As a general rule of thumb all terminations of the vessel, that is the stem and stern should be faired to prevent undue drag and the creation of turbulence. The slope of this fairing should not be greater than 1:4. This is particularly applicable to both wooden and G.R.P. hulled vessels. Poor appendage fairing can seriously decrease, particularly the propeller performance.

Hull openings, such as bow thruster tunnels, should be faired and fairings should be fitted around sensors to improve their performance and reduce their drag.

FIG 12 An overlooked area of design is the rudder. Good manouverability provides good course keeping and control of the vessel when fishing at low speeds. Since early 1970s there has been a marked change in the rudder design approach, from pure reaction of the water on the rudder to obtaining reaction from the jet stream developed by guiding water.

7. Appendage Design Cont'd.

Some of these rudder designs may be too expensive for the small fishing vessel but even the single plate version should be designed carefully.

a) The rudder area should be 4 - 5% of the underwater profile area of the hull.

b) The rudder stock should be about 25% of the rudder width from the leading edge, to give good balance and a smaller steering gear.

c) The rudder should not be located with its centreline in line with trawl blocks or no leverage will occur and the vessel will not steer when towing the net.

d) Particularly in wooden and G.R.P. vessels that may have wide stern posts or the steel vessel with a box keel, it is worth locating a vertical angle bar with its heel on the after end of the rudder, which will provide steering at low rudder angles as the arms of the angle will enter the open water earlier.

FIG 12 shows recent developments in rudder design. The Becker rudder has been fitted on the combination longliner gillnetter in Newfoundland and has proved very effective. The flap on the after end of the rudder is geared to turn through a larger angle than the rudder, hence reaching the open water at low helm angles.

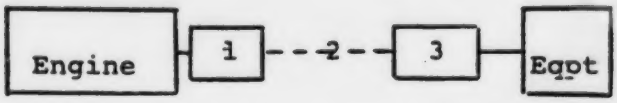
The rotor cylinder rudder gives lamminar flow over the rudder reducing drag and increasing lift.

The fish shaped rudder smooths the flow, operates at low angles of helm and the top plate holds the water down onto the rudder providing a higher turning moment.

TRANSMISSION SYSTEMS COMPARISON

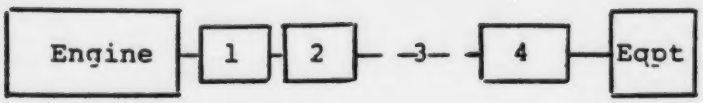
FIG 16

Electrical



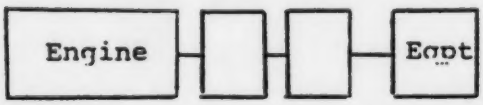
Item	Efficiency%
1.Generator A/C	92
2.Cabling	90
3.Motor	76- 84

Hydraulic



Item	Efficiency%
1. P.T.O.	95
2.Pump	80
3.Piping	90
4.Motor	85

Mechanical



Item	Efficiency%
1.Clutch/P.T.O.	95
2.Gear/Belting	95

System	Overall Efficiency	Disadvantages
Electrical	70%	Start up load & constant speed
Hydraulic	58%	Poor efficiency
Mechanical	90%	Equipment close to engine & constant maintenance.

8. Examples

We would like to illustrate some of the preceeding with examples of poor and sensible designs and have used as an example a 65 ft. vessel with various fishing modes. Some of the illustrations are applicable to the various designs and materials, other areas are specific to the particular design requirements.

9. Transmission Efficiencies and Auxiliary Power

FIG 16

We have dealt with the main obsorber of energy but another area requires attention, namely the use of auxiliary power. The main means of power transmission to the systems are the following:

a) Electrical
b) Hydraulic
c) Mechanical

Electrical transmission is by far the most efficient means of power transmission but has a serious draw back in that for large motor power demands the start up current can be six to seven times the running current, or even the low voltage starters three to four times. This can be handled in two ways, either with interlocks between the motors , or with controlled start up. The transmission efficiency of an electrical system is in the mid 90% range.

Electrical systems will operate in poor operating conditions sometimes found on fishing vessels. The one area that is now in review is the dependence on the 32 d.c. system in small fishing vessels. We have to seriously consider, from an initial cost and future supply aspect, the use of either three phase or at least single phase a.c. systems with the use of d.c. systems for electronic and emergency systems only.

9. Transmission Efficiencies and Auxiliary Power Cont'd.

Hydraulic systems have proven more than adequate to handle the large fishing equipment demands, although the transmission efficiency is very poor. The efficiency of the pump is in the order of 80% and the motor 85% and the pipe losses would amount to some 10% additional loss, which would give an overall transmission efficiency of some 61%. The cost of electric winches is prohibitive and therefore the main drive has been to fit hydraulic powered deck equipment.

This brings up the main question in the design of draggers, how much should the winch pull exceed the vessel pull and how large should the ancillary winches, such as gilsons, be?

We would like to make one thing clear, we have a dislike of hydraulic powering of large equipment, but, in recent years, there has been an uncontrolled and unchecked demand for ever larger winch pulls. This is an area that we would wish to discuss thoroughly. We find it very difficult to understand why the winch pull can be as much as 100% greater than the propeller pull. The arguement of towing and hauling a larger net does not, like the net, hold water. It is realized that, especially when bottom trawling, there is a necessity to be able to accelerate the net over the bottom to make it rise over an obstruction and that the forces are absorbed to an extent in the elasticity of the warps. Added to this, most winches are powered off front end take offs on the main engine and therefore, if the winch is used

9. Transmission Efficiencies and Auxiliary Power Cont'd.
the power availalbe to the propeller is reduced by that required for the winch. Therefore, we would anticipate that an ample margin over the propeller bollard pull would be 10%. We can see no point in winching the vessel back to the net except to save a little hauling time, as the speed of the net through the water is limited by the vessel pull and the only gain would be the difference in pull between the towing speed and bollard pull, but with reduced power available to the propeller.

The second area of concern is that of oversized gilsons. We have uncovered gilsons with greater pulls than the main winch. This practice of dragging the cod end across the deck with large pulls must make for very poor quality of fish. We would rather advocate that the bag be lifted thus some drag removed and smaller gilsons fitted. With transmission efficiencies of 61% the above would seem an expensive luxury.

The third area of concern is the use of hydraulic power for driving bilge/ballast pumps or fire pumps. Although it is very convenient to operate this way it is an inefficient use of energy.

Mechanical transmissions have efficiencies in the 80% depending on their complexity. Their main advantage is that they are normally inexpensive and readily maintained. Their main disadvantage is that they require constant maintenance or they will rapidly deteriorate.

ENGINE
MAINTENANCE.10. Maintenance Programmes

I have always admired the North American attitude that machinery will automatically run whether maintained poorly or not and in marine equipment, which is very robust design, this is more so.

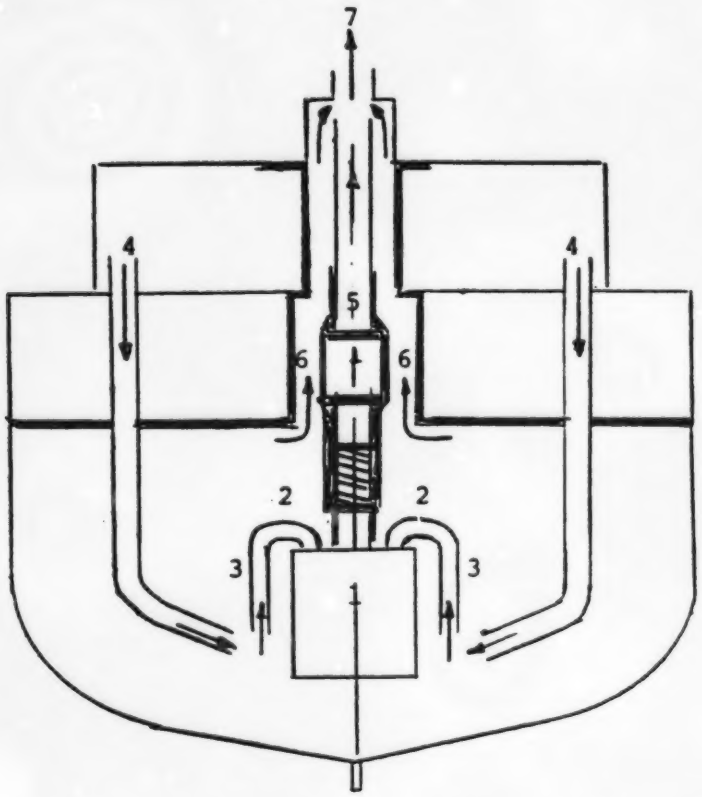
However, nothing reduces efficiency and increases power demand of equipment more than poor maintenance. The squeaky wheel generating heat and therefore using energy. Complete maintenance programmes however would be costly and time consuming but, if limited to a few major absorbers of energy, could well pay off. Most engine suppliers have maintenance programmes for their engines and as major absorbers of energy should be well worth a maintenance programme. Gearboxes, large pumps and winches likewise should be maintained on a regular basis.

There can be nothing more frustrating to a fisherman than to await the fishing season only to have a breakdown in major equipment early in the season. The single avoidance of one such breakdown could well pay for the years maintenance cost. These programmes would seem sensible especially as the engineer has so little time for such work once the fishing has commenced.

With the high cost of operation and the limited income due to quotas, there is a tendency to only carry out overhauls when inspection is required by Coast Guard. By monitoring your main equipment you will be able to estimate whether inspections at such intervals are sufficient.

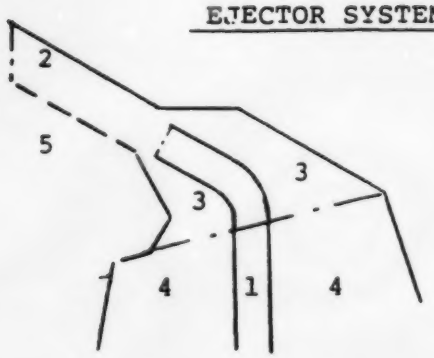
ENGINE ROOM AIR & EJECTOR SYSTEM

FIG 14



1.Main Engine
2.Air cleaner
3.M.Engine Intake
4.Cold Air Intake
5.Main engine Exhaust
6.Engine Room Air Exhaust
7.Eductor System
N.B.Shading Denotes Insulation

EJECTOR SYSTEM



1.Exhaust pipe.
2.Ejector mixing section
3.Ejector entrance section
4.Exhaust stack and hot air vent.
5.Water drains.

11. Insulation and Heat Loss

No-one would build a wooden house without ample insulation. Nor would the fisherman risk poor insulation of his holds. There is a tendency to increase the heat rather than apply sufficient insulation in accommodation spaces. Insulation also should be extended beyond the area intended to be insulated, especially in steel vessels. It is normally run about a meter beyond the boundary. It is worth remembering that good insulation has the opposite result in summer of preventing the ingress of heat.

In steel or aluminum vessels, especially adequate insulation should be fitted over frames or cold spots will occur. Exterior doors should be self closing and if possible insulated.

12. Waste Heat Systems

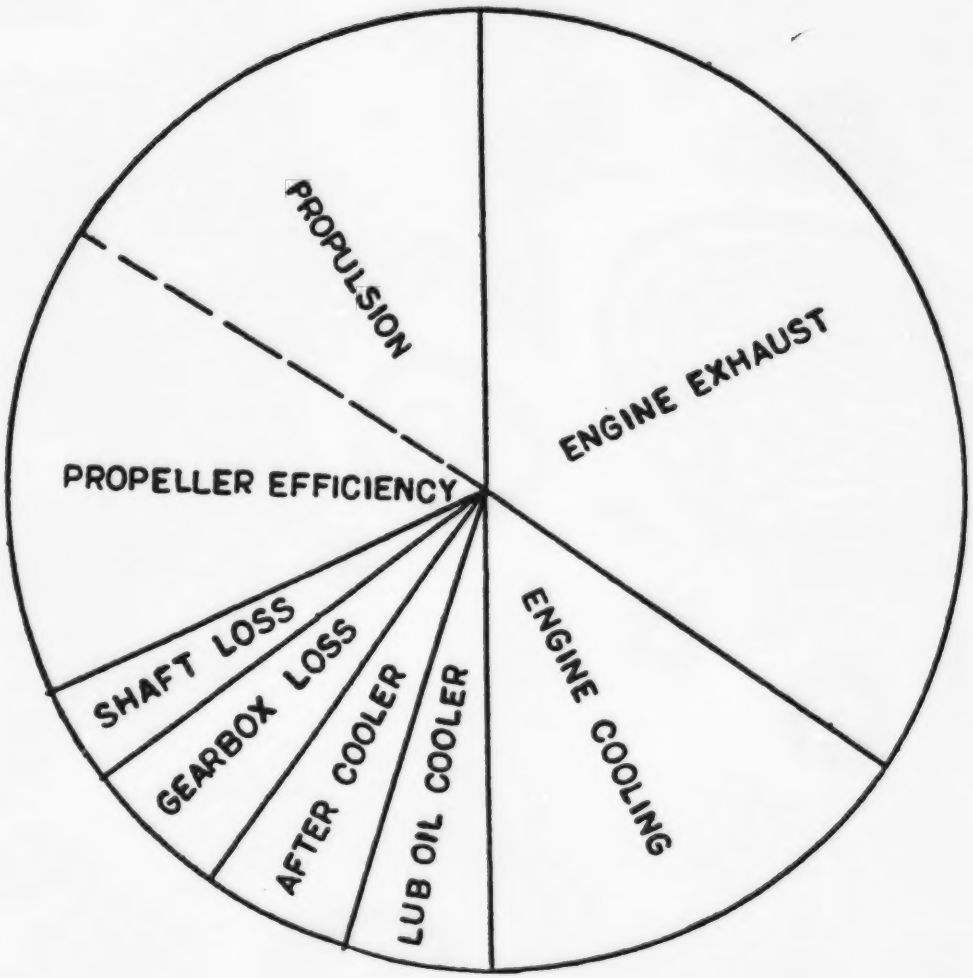
The main source of waste heat is the main engine, this heat can be harnessed to augment at least the normal heating systems. Even in larger deep sea fishing vessels the use of waste heat boilers has not proven advantageous but heat exchangers can be used either for heating the accommodation spaces or water.

FIG 14

As an example,the idea of leaving a section of the upper exhaust ducting from the main engine uninsulated thus generating convection up the casing and either removing or reducing the capacity of the engine room fans, has long been in use.

The electrical heat demand can be reduced significantly by passing the engine cooling water, be it raw water of keel cooled, via a water radiator system to augment the fitted heating in the accommodation.

BREAKDOWN OF ENERGY COMPONENTS OF THE PROPULSION SYSTEM FIG 13



VESSELS TESTED FOR FUEL CONSUMPTION FIG 15

1984-85 ENERSEA PROGRAMME

Vessel Length	Engine Power Maximum	% Fuel Saved Dropping Maximum Speed One (1) Knot
feet	B.H.P.	%
42	210	47
45	165	56
45	218	35
51	107	36
38	72	42
45	85	40
36	41.5	29
35	85	41
35	125	45
38	156	40
52	165	38
52	220	34
42	130	52
39	130	42
65	520	29
42	125	55
38	117	30
42	154	40
45	165	49
58	230	34
65	365	40
	Average % Drop	41%

13. The Energy Pie

FIG 13

This figure illustrates the total energy use for a four cycle marine diesel engine. Some 35% is exhausted to the atmosphere, 15% in cooling the engine to an operational level, 5% in cooling the lubricating oil, 5% in the after cooler, 5% absorbed by the gearbox transmission, 3% in propeller shaft losses. This leaves 32% for actually propelling the vessel and if the propeller is 50% efficient only 16% is actually providing the propeller thrust.

Hence, we can see the need for use of the engine exhaust or engine cooling systems waste heat to be utilized. All our efforts to improve hull or propeller design really can only effect the actual energy use slightly.

FIG 15
CUTTING THE COST

So how can we best use the energy? Mainly in the displacement type boat by reducing speed. From actual full scale fuel consumption measurements taken in Newfoundland by the Department of Fisheries and Oceans for the range length of vessels that we are concerned with, by dropping the vessel speed one knot the average fuel consumption saving was 41%. For the displacement boat speed in money.

For the planing type of vessel the reduction would be approximately one third, or 13%, still a significant saving.

14. Efficient Use of Energy

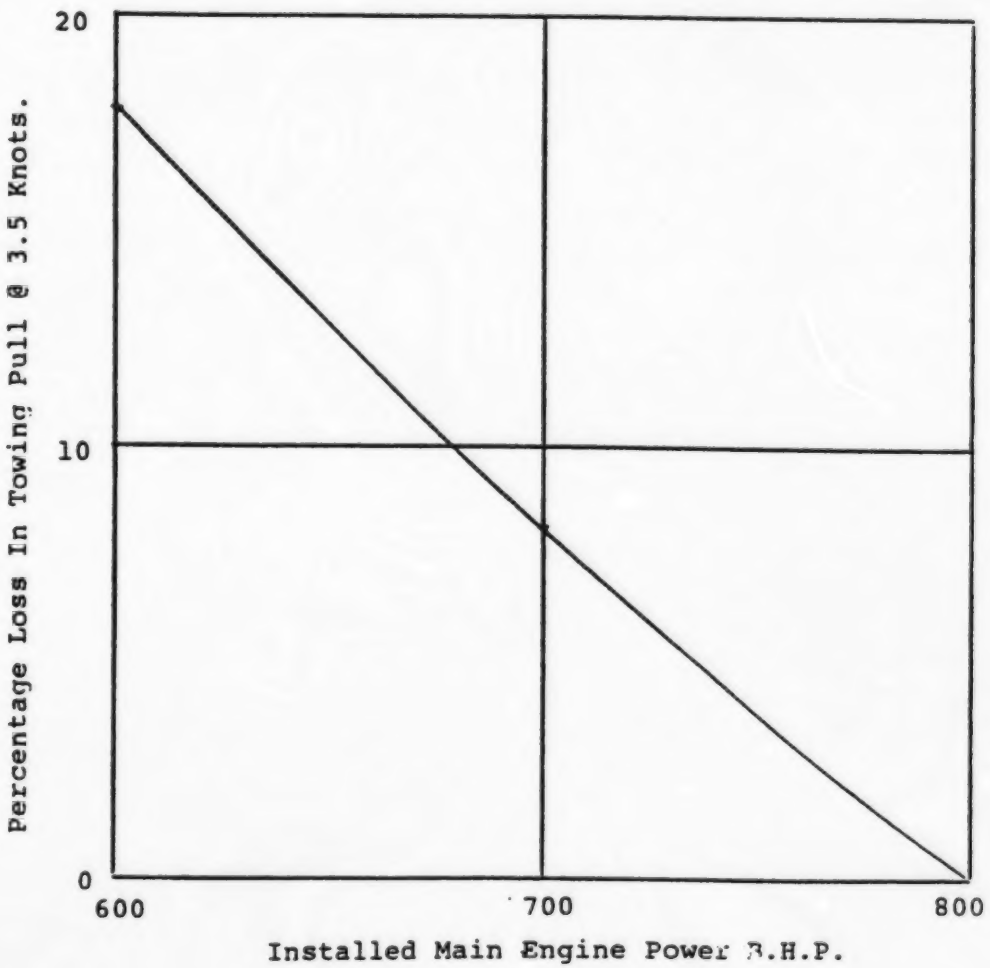
FIG 14

One of the major problems that we encounter on the small fishing vessel is lack of air to the engine room. Remember, for air to enter it must be able to escape. Two uses are made of the cool air entering the engine room, combustion air burnt with the fuel, and cooling air required to keep the engine room sufficiently cool so the engine does not overheat.

65FT STERN TRAWLER

FIG 17

REDUCTION IN TOWING PULL WITH REDUCTION IN INSTALLED MAIN ENGINE POWER



ENGINE ROOM AIR REQUIREMENTS FIG 18

Combustion Air 2.5 c.f.m./BHP

Cooling Air $C = H/0,24WT_r$

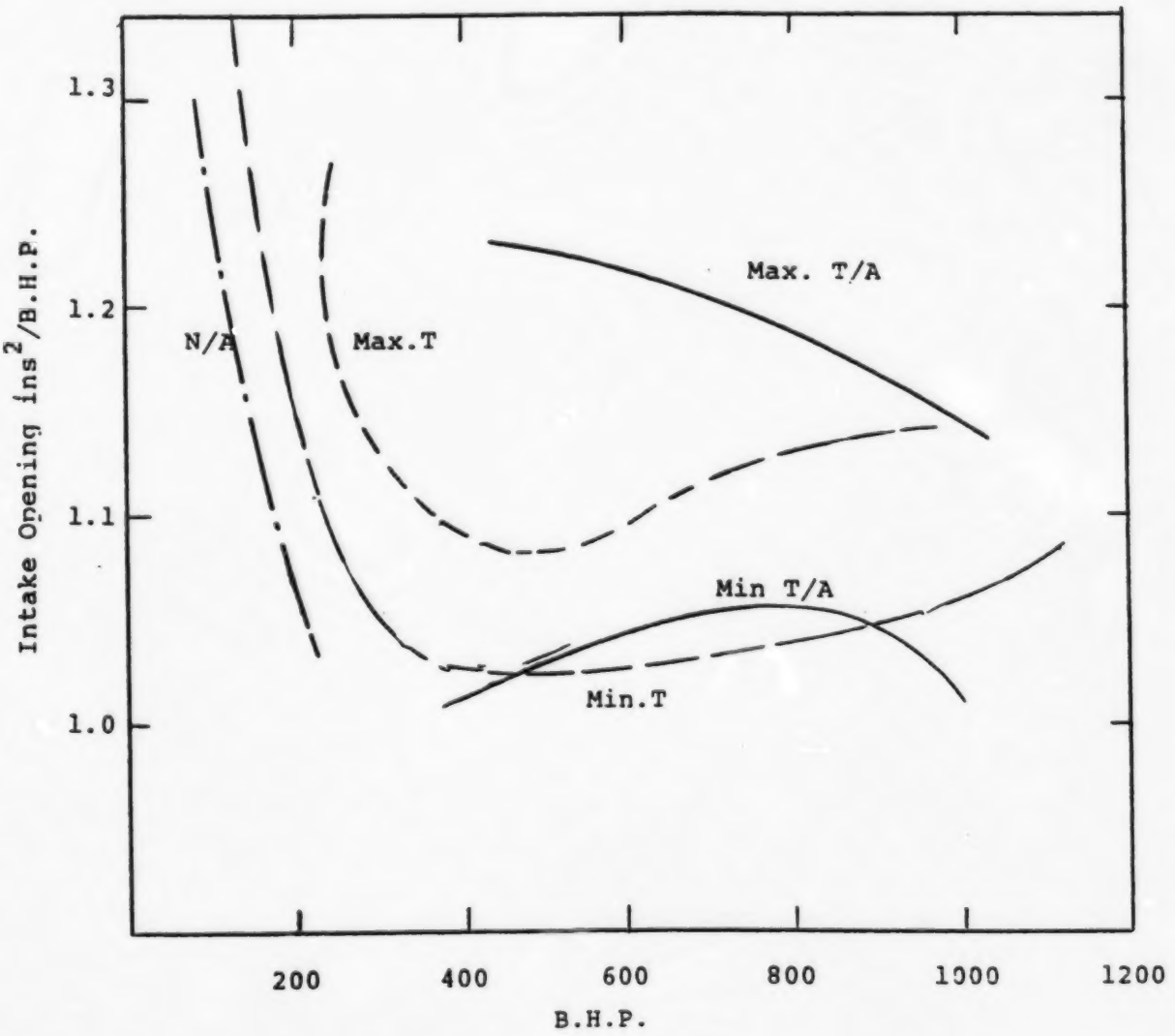
Where H Heat Rejection BTU/Min W Specific Weight of Air

Tr Engine Room Temp Rise Over Ambient ^{o}F

Intake Opening Maximum Air Velocity 1,000 c.f.m.

Duct Velocity 2,000 c.f.m.

Duct Area ½ Intake Area.



14. Efficient Use of Energy Cont'd.

FIG 18

Based on manufacturer's data we have tried to present air requirements for the four stroke diesel engine in a practical way. The intake velocity in the intake bellmouth should not exceed 1,000 cfm. or excessive noise will result and the velocity in the ducting should be about 2,000 cfm. From the diagram it will be seen that the duct intake area should be about 1.0 square inch/bhp. and the duct itself about ½ square inch/bhp. The air should be led via ducting low into the engine room, close to the engine breather and permitted to exhaust by the natural convection of the engine room out the casing.

15. Preconceived Design Requirements

FIG 17

One of the main problems in fishing vessel design is the preconceived requirement, this diagram is a good example. With the total fleet fish quota approach it is essential that the Owner catch the maximum amount of fish while the quota lasts. To achieve this large nets are now being installed on the smaller vessels, requiring ever increasing power to handle the fishing gear.

If we analyse the pull generated for a 65 ft. vessel with a variation in installed power the results are very illuminating:

BHP	Pull % of BHP Pull	Problem
800	100	Diameter too small,area larg
700	92	Diameter too small
600	83	Diameter optimum

FIG 19

ATLANTIC REGION OIL PRICES

	NOMINAL PRICES $/BARREL	NOMINAL PRICES c/LITRE	REAL PRICES $/BARREL	REAL PRICES c/LITRE
1970	2.51	3.99	0.77	1.22
1971	2.75	4.37	0.87	1.38
1972	3.53	5.61	1.16	1.85
1973	4.16	6.61	1.48	2.35
1974	6.46	10.27	2.55	4.06
1975	8.04	12.78	3.51	5.58
1976	9.30	14.79	4.37	6.95
1977	11.07	17.60	5.62	8.93
1978	13.67	21.74	7.50	11.92
1979	14.75	23.45	8.90	14.15
1980	18.19	28.92	12.09	19.22
1981	27.65	43.96	20.67	32.87
1982	33.76	53.68	27.96	44.45
1983	36.38	57.84	31.86	50.65
1984	37.95	60.34	34.69	55.15
1985	38.01	60.44	36.13	57.45
1986	21.07	33.50	21.07	33.50
1987	25.29	40.21	26.30	41.82

16. Conclusions

FIG 18

The energy crisis is alive and well. We have, at present, a remission due to the drop in world demand and prices, but the spiral is starting again. This diagram is our prediction of the cost of crude oil per barrel. The solid line represents the actual recorded price, the dotted line our prediction.

By 1993 the price of oil will be between $45 and $55 per barrel. With Canadian production becoming viable the top value would fall about $2 per barrel. The cost now is $26, the increase by 1993 will be 73 - 115% over today's price. We should not wait until this happens. It is obvious that these increases can only be delayed by our conservation efforts and we know that this was why prices steadied and then dropped dramatically between 1982 and 1986. If you do not wish to price your fish out of the market you must conserve fuel.

New Brunswick
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Canada